

the "figuring" of mirrors. But it is otherwise with chromatic aberration. Sensibly to change the colour for which an objective has minimum focus means a very considerable alteration, one which it would be hopeless to try and effect by *any* polishing process; it means an alteration by turning and subsequent regrinding of the tools employed, and a complete reworking of at least one surface of the objective; or a still greater alteration of two surfaces if a given focus is to be maintained. And if the sine-condition is to be fulfilled, matters become even worse.

The well-known type of object-glass, for instance, which consists of an equi-convex crown and a practically plano-concave flint, offends against the sine-condition to the extent of a difference of magnification between centre and margin, which is of the small order of one-tenth of one per cent. Yet to correct this comparatively slight error and to secure images as symmetrical as should be demanded for photographic purposes, the crown-lens will have to be altered until the curvature of its outside is about half that of the inside, whilst the flint-glass will have assumed a pronounced meniscus-form, if indeed it should be at all possible to carry out so drastic an alteration without making the glasses too thin. In fact, it may be stated, without fear of serious contradiction, that it will always be a hard task to produce by rule of thumb an objective having *minimum focus for a prescribed wave-length*, and that it would be a hopeless enterprise to try to rigorously fulfil the sine-condition without careful computation.

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*On the Large Sun-spot of 1905 January 29-February 11, and Contemporaneous Magnetic Disturbances, observed at the Royal Observatory, Greenwich.*

(Communicated by the Astronomer-Royal.)

The largest sun-spot as yet photographed at the Royal Observatory, Greenwich, appeared at the east limb of the Sun on 1905 January 28, and passed off at the west limb on February 11. This was the rotation in which it attained its greatest dimensions; but it had been seen in the preceding rotation as well, and reappeared in the third rotation. It was first photographed at Greenwich on January 7, that day being the first occasion on which solar photographs were obtained this year. It is therefore not yet certain as to whether the group formed first in the visible hemisphere or in the one turned from us. If the latter, it would have come into view at the east limb on January 1. The group is now (March 10) completing its third rotation and passing out of sight at the west limb. The Sun was photographed at Greenwich upon five days during the first apparition of the group, upon ten days during the second,

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and upon seven days during the third. The photographs taken during the first two apparitions have all been measured and reduced ; but there has been only time enough as yet to measure one taken during the third.

When first seen, on January 7, the group consisted of a scattered stream of rather small faint spots, the leader spot being the only one at all dark or well defined. Many of the faintest of these small spots disappeared on the succeeding days, and on January 12 only four small spots remained.

Date. Greenwich Civil Time.	Projected Area of		Area for Group corrected for		Mean Longitude of Group.	Mean Latitude of Group.	Longitude from Central Meridian.
	Umbra.	Whole Spot.	Umbra.	Whole Spot.			
1905. d							
Jan. 7 <sup>540</sup>	25	246	13	130	321°5	-18°2	-12°0
11 <sup>401</sup>	25	167	17	112	323°4	-17°1	+40°7
12 <sup>471</sup>	12	85	12	77	324°3	-17°0	+55°7
13 <sup>473</sup>	11	119	16	155	323°7	-17°3	+68°3
14 <sup>440</sup>	0	7	0	15	320°3	-18°1	+77°7

The projected areas are expressed in millionths of the Sun's apparent disc, the corrected areas in millionths of the Sun's visible hemisphere.

The group on January 12 was 11° of solar longitude in length and about 2° of solar latitude in breadth. Its length on January 7 was 8° of longitude. It began to cross the central meridian January 8<sup>d</sup> 3<sup>h</sup>, and had completely passed by January 8<sup>d</sup> 17<sup>h</sup>, the centre of the group passing January 8<sup>d</sup> 10<sup>h</sup>. The group was not observed on January 15, but must have passed from the visible hemisphere on that day.

The group returned to the east limb on January 28, but no photographs were obtained on that day. It was photographed on January 29, and after that, day by day continuously, except on February 4, 7, and 9, until it reached the west limb on February 11. It was now altogether changed in appearance, being a single spot of enormous dimensions and most complex structure. On February 3 it was 16° of solar longitude in extreme length and 7° of solar latitude in extreme breadth. The principal umbra appeared to be rather small in proportion to the entire area of the spot, and was crossed in several directions by an intricate system of bright bridges ; smaller umbrae, less dark and definite, were scattered irregularly in the widely extended penumbral regions. As the spot neared the west limb the irregular extensions on all sides, but especially in the front and rear, tended to become quite separated from the main spot, which was further divided by two bright bridges, at right angles to its length, extending almost completely across it.

March 1905. *Sun-spot of 1905 January and February.* 511

Date. Greenwich Civil Time.	Projected Area of		Area for Group corrected for Foreshortening		Mean Longitude of Group.	Mean Latitude of Group.	Longitude from Central Meridian.
	Umbra.	Whole Spot.	Umbra.	Whole Spot.			
1905. d							
Jan. 29 <sup>h</sup> 49 <sup>m</sup> 7 <sup>s</sup>	182	1771	327	3190	329° 3'	-15° 7'	-75° 0'
30 <sup>h</sup> 499	300	2690	310	2784	329° 5'	-15° 6'	-61° 6'
31 <sup>h</sup> 470	420	4222	320	3218	329° 2'	-15° 6'	-49° 2'
Feb. 1 <sup>h</sup> 461	641	5119	398	3180	329° 8'	-15° 7'	-35° 5'
2 <sup>h</sup> 451	935	6139	508	3339	329° 9'	-15° 2'	-22° 3'
3 <sup>h</sup> 458	1037	6293	532	3229	329° 3'	-15° 6'	-9° 7'
5 <sup>h</sup> 517	656	5221	348	2771	329° 5'	-14° 8'	+17° 5'
6 <sup>h</sup> 672	399	4321	235	2472	328° 1'	-14° 7'	+31° 4'
8 <sup>h</sup> 544	201	2664	179	2369	328° 4'	-14° 7'	+56° 4'
10 <sup>h</sup> 539	56	440	163	1252	327° 2'	-14° 8'	+81° 3'

The great spot could just be perceived as a very slight dark mark on the west limb on February 11, but it was not possible to measure it.

It was next photographed on February 25, when it had again returned to the east limb. It was now not nearly as large as during the preceding rotation, but was still a very fine group. Its form was now that of an extended stream, the principal spot being very large and complex, with two or three regular spots following it, and a few very small faint spots preceding it. The extreme length of the group on March 4 was 13° of solar longitude, its extreme breadth 5° of solar latitude.

Another great spot, but in the northern hemisphere, appeared at the east limb on March 1. This, like the group of January 28 to February 11, was a single spot of great complexity of detail. It was represented during the preceding rotation by quite a small group, a short stream at the head of a long scattered procession of groups following each other at considerable intervals. The same general region had been disturbed during December, but there does not seem to have been an unbroken persistence of actually the same spot-group.

This northern group showed a strong tendency to extend itself in longitude. On March 4 it had an extreme length in longitude of 15½°, on March 6 of 18°, its extreme breadth being about 7° of solar latitude. Up to the present only one photograph taken during the joint appearance of these two great spots has been measured and reduced. This was taken on March 4, when the areas and mean positions for the two groups were as follows :

Group, 1905 March 4.	Projected Area of		Area for Group corrected for Foreshortening		Mean Longitude of Group.	Mean Latitude of Group.	Longitude from Central Meridian.
	Umbra.	Whole Spot.	Umbra.	Whole Spot.			
Southern Group	305	2358	159	1224	330° 3'	-16° 7'	+12° 8'
Northern Group	242	3133	189	2447	270° 3'	+10° 6'	-47° 2'

The following table gives the times when the Southern Group crossed the central meridian, and the angular distance between the centre of the group and the centre of the disc at the time of transit :

Times of Transit across the Central Meridian of the Southern Group.			Duration of Transit.	Distance of Centre from Centre of Disc.
Beginning. 1905. d h	Centre. d h	End. d h		
Jan. 8 3	Jan. 8 10	Jan. 8 17	14	- 14.2
Feb. 3 14	Feb. 4 4	Feb. 4 18	28	- 9.3
Mar. 3 0	Mar. 3 11	Mar. 4 0	24	- 9.4

The successive times of transit of the centre of the group give the intervals  $26^d 18^h$ , and  $27^d 7^h$  for the observed synodic rotation. The mean synodic rotation period for a spot in latitude  $-15^\circ$  is given by Carrington as  $27^d 3^h$ .

The Northern Group would appear to have been in transit about the following times :

Times of Transit across the C.M. of Northern Group.			Duration of Transit.	Distance of Centre from Centre of Disc.
Beginning. d h	Centre. d h	End. d h		
March 7 8	March 8 0	March 8 17	33	+ 17.8

No really violent magnetic disturbance has taken place during the passage of these two great spots, but there have been several disturbances of moderate amount. The following table gives all the disturbances since 1905 January 1 in which the amplitude of the movement has exceeded  $10'$  in declination, or  $60\gamma$  in horizontal force :

Period of Disturbance. Greenwich Civil Time.		Range in Declination.	Range in Horizontal Force (approximate).
From 1905. d h	To 1905. d h		
Jan. 5 17	Jan. 6 0	30	140 $\gamma$
14 19	15 3	16	60
20 20	20 22	15	< 50
Feb. 1 21	Feb. 2 5	12	75
3 2	3 23	45	240
4 18	4 20	24	110
5 12	5 22	20	70
14 20	14 23	18	80
15 20	15 23	16	50
22 20	23 3	14	< 50
Mar. 2 13	Mar. 3 2	29	200

Royal Observatory, Greenwich :  
1905 March 10.

*Spectroscopic Observations of the Recent Great Sun-spot and Associated Prominences.* By A. Fowler.*Introductory.*

The great sun-spot which was so conspicuous during the last three days of January and the early part of February presented several features of interest when examined with the spectroscope, and it may be useful to give an account of the phenomena observed. Observations of the spectrum were made on January 31, February 1, 2, and 3, and after the return of the spot on February 25, 28, March 3 and 6. The prominences overlying the spot as it passed over the western limb on February 11 were also observed and the spectrum recorded in considerable detail.

All the observations were made with an Evershed solar spectro-scope attached to a 6-inch refractor.

*Reversals of Lines.*

During the first passage of the spot across the disc the C and F lines of hydrogen were brightly reversed, but on its return the reversals were less pronounced and could not be seen at all on March 6. The  $D_3$  line of helium was a prominent feature for a short time on February 2, and was also noted on February 25. Reversals of the sodium lines  $D_1$  and  $D_2$  were very conspicuous during the earlier stages, but were not seen after the return of the spot. The magnesium lines  $b_1$ ,  $b_2$ , and  $b_4$  and the iron line  $b_3$  were observed to be reversed on January 31, and again, together with many other lines, on February 2. Details of the observations are as follows :

*January 31 (9.50 A.M.—2.30 P.M.).*—C and F were brilliantly reversed in numerous places over a large area, and especially over the greater part of the largest umbra.  $D_3$  was suspected as a bright line.  $D_1$  and  $D_2$  were brightly reversed over the two largest umbræ, and the four  $b$  lines were seen bright on the inner edge of the principal umbra, where C and F were brightest. The displacements of the lines were very slight.

*February 1 (11–11.20 A.M.).*—C and F were reversed as on the previous day, but the displacement of the (dark) lines were more marked ; the greatest displacement was about 2 tenth metres.  $D_3$  was not observed, but  $D_1$  and  $D_2$  were reversed as on January 31.

*February 2 (9.45–12).*—From 9.45 to 10 A.M. there was an eruption over the spot, during which the C line in a region preceding the principal umbra was expanded into a cloudy form extending about 5 tenth metres towards the red ; over the umbra the line was also brilliantly reversed, but occupied its normal position.  $D_3$  was also very conspicuous, and, so far as